CLAIMS

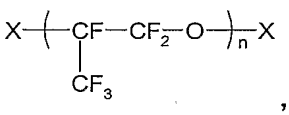
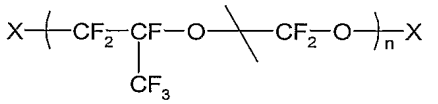
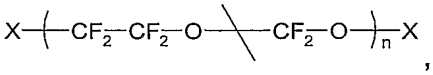
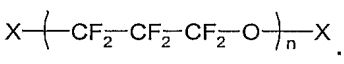
What is claimed is:

1. A microfluidic device comprising a perfluoropolyether (PFPE) material, wherein the PFPE material is prepared from a liquid PFPE precursor material having a characteristic selected from the group consisting of (i) a viscosity greater than about 100 centistokes (cSt), (ii) a viscosity less than about 100 cSt, provided that the liquid PFPE precursor material having a viscosity less than 100 cSt is not a free-radically photocurable PFPE material, and (iii) combinations thereof.

2. The microfluidic device of Claim 1, wherein the liquid PFPE precursor is end-capped with a polymerizable group.

3. The microfluidic device of Claim 2, wherein the polymerizable group is selected from the group consisting of an acrylate, a methacrylate, an epoxy, an amino, a carboxylic, an anhydride, a maleimide, an isocyanato, an olefinic, and a styrenic group.

4. The microfluidic device of Claim 1, wherein the liquid PFPE precursor material comprises a backbone structure, wherein the backbone structure is selected from the group consisting of:

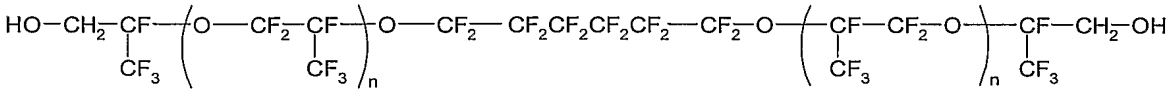

,

,

, and

;

and wherein:

X is present or absent, and when present comprises an endcapping group, and

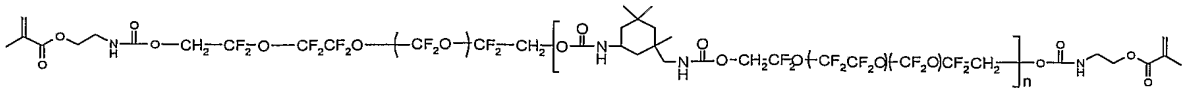
n is an integer from 1 to 100.

5. The microfluidic device of Claim 1, wherein the liquid PFPE precursor material comprises the following structure:



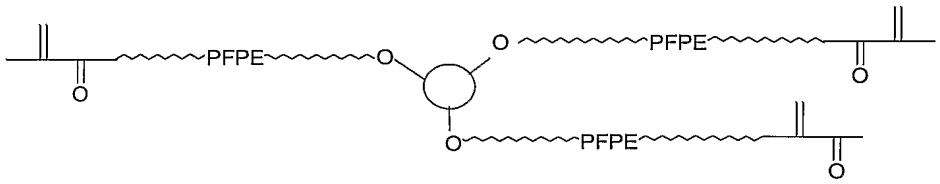
wherein n is an integer from 1 to 100.

6. The microfluidic device of Claim 1, wherein the liquid PFPE precursor material comprises the following structure:



wherein n is an integer from 1 to 100.

7. The microfluidic device of Claim 1, wherein the liquid PFPE precursor material comprises a compound comprising the following structure:



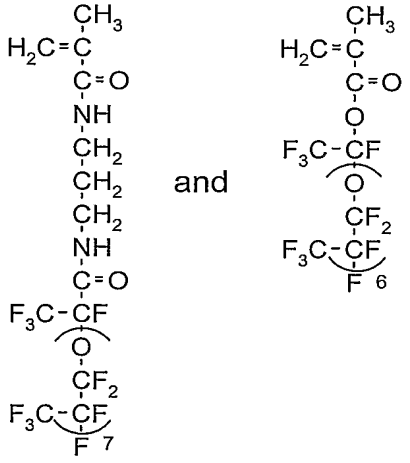
wherein:

the circle comprises a multifunctional linking molecule; and

PFPE comprises a perfluoropolyether chain.

8. The microfluidic device of Claim 1, wherein the liquid PFPE precursor material comprises a hyperbranched PFPE liquid precursor material.

9. The microfluidic device of Claim 1, wherein the liquid PFPE material comprises an end-functionalized material selected from the group consisting of:



10. The microfluidic device of Claim 1, wherein the liquid PFPE material comprises a functional monomer.

11. The microfluidic device of Claim 10, wherein the functional

monomer is selected from the group consisting of a styrene, a methacrylate, an acrylate, acrylamide, acrylonitrile, and vinyl pyridine.

12. The microfluidic device of Claim 11, wherein the styrene is selected from the group consisting of pentafluorostyrene, bromostyrene, chlorostyrene, styrene sulfonic acid, fluorostyrene, and styrene acetate.

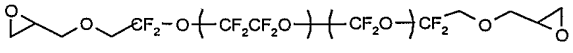
13. The microfluidic device of Claim 11, wherein the methacrylate is selected from the group consisting of tert-butyl methacrylate, dimethylaminopropyl methacrylate, glycidyl methacrylate, hydroxy ethyl methacrylate, aminopropyl methacrylate, a cyano methacrylate, a trimethoxysilane methacrylate, isocyanato methacrylate, a lactone-containing methacrylate, a sugar-containing methacrylate, polyethylene glycol methacrylate, a nornornane-containing methacrylate, polyhedral oligomeric silsesquioxane methacrylate, 2-trimethylsiloxyethyl methacrylate, and 1H,1H,2H,2H-fluoroctylmethacrylate.

14. The microfluidic device of Claim 11, wherein the acrylate is selected from the group consisting of tert-butyl acrylate, allyl acrylate, a cyano acrylate, a trimethoxysilane acrylate, a lactone-containing acrylate, a sugar-containing acrylate, poly-ethylene glycol methacrylate, and a nornornane-containing acrylate.

15. The microfluidic device of Claim 1, wherein the liquid PFPE precursor material comprises a two-component liquid PFPE precursor system comprising a mixture of two functionalized PFPE components blended in a stoichiometric ratio.

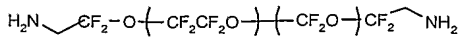
16. The microfluidic device of Claim 15, wherein the two-component PFPE precursor system comprises a mixture of components selected from the group consisting of: an epoxy/amine mixture, a hydroxyl/isocyanate mixture, a hydroxyl/acid chloride mixture, and a hydroxyl/chlorosilane mixture.

17. The microfluidic device of Claim 16, wherein epoxy/amine mixture comprises a PFPE diepoxy compound comprising the following structure:



; and

a PFPE diamine compound comprising the following structure:



18. The microfluidic device of Claim 16, wherein the epoxy/amine mixture comprises a stoichiometric ratio ranging from about 4:1 epoxy:amine to about 1:4 epoxy:amine.

19. The microfluidic device of Claim 1, wherein the liquid PFPE precursor material is blended with a functional species, wherein the functional species is mechanically entangled into a PFPE network upon curing.

20. The microfluidic device of Claim 1, wherein the perfluoropolyether (PFPE) material comprises a thermally-cured liquid PFPE precursor material.

21. The microfluidic device of Claim 1, wherein the perfluoropolyether (PFPE) material comprises a chemically-cured liquid PFPE precursor material.

22. The microfluidic device of Claim 1, wherein the perfluoropolyether (PFPE) material comprises a photoacid-cured liquid PFPE precursor material.

23. The microfluidic device of Claim 1, wherein the PFPE material is transparent to one of UV light, visible light, and combinations thereof.

24. A microfluidic device comprising a fluoroolefin-based elastomer, wherein the fluoroolefin-based elastomer comprises a first monomer and at least one additional monomer, wherein the first monomer and the at least one additional monomer are different, and wherein:

(a) the first monomer is selected from the group consisting of vinylidene fluoride and tetrafluoroethylene; and

(b) the at least one additional monomer is selected from the group consisting of a fluorine-containing olefin, a fluorine containing vinyl ether, a hydrocarbon olefin; and combinations thereof.

25. The microfluidic device of Claim 24, wherein the fluorine-containing olefin is selected from the group consisting of vinylidine fluoride, hexafluoropropylene (HFP), tetrafluoroethylene (TFE), 1,2,3,3,3-pentafluoropropene (1-HPFP), chlorotrifluoroethylene (CTFE), and vinyl

fluoride.

26. The microfluidic device of Claim 24, wherein the fluorine-containing vinyl ether comprises a perfluoro(alkyl vinyl) ether.

27. The microfluidic device of Claim 24, wherein the hydrocarbon olefin is selected from the group consisting of ethylene and propylene.

28. The microfluidic device of Claim 24, wherein the fluoroolefin-based elastomer comprises copolymerized units of:

vinylidene fluoride and hexafluoropropylene;

vinylidene fluoride, hexafluoropropylene and tetrafluoroethylene;

vinylidene fluoride, hexafluoropropylene, tetrafluoroethylene and 4-bromo-3,3,4,4-tetrafluorobutene-1;

vinylidene fluoride, hexafluoropropylene, tetrafluoroethylene and 4-iodo-3,3,4,4-tetrafluorobutene-1;

vinylidene fluoride, perfluoro(methyl vinyl) ether, tetrafluoroethylene and 4-bromo-3,3,4,4-tetrafluorobutene-1;

vinylidene fluoride, perfluoro(methyl vinyl) ether, tetrafluoroethylene and 4-iodo-3,3,4,4-tetrafluorobutene-1;

vinylidene fluoride, perfluoro(methyl vinyl) ether, tetrafluoroethylene and 1,1,3,3,3-pentafluoropropene;

tetrafluoroethylene, perfluoro(methyl vinyl) ether and ethylene;

tetrafluoroethylene, perfluoro(methyl vinyl) ether, ethylene and 4-bromo-3,3,4,4-tetrafluorobutene-1;

tetrafluoroethylene, perfluoro(methyl vinyl) ether, ethylene and 4-iodo-3,3,4,4-tetrafluorobutene-1;

tetrafluoroethylene, propylene and vinylidene fluoride;

tetrafluoroethylene and perfluoro(methyl vinyl) ether;

tetrafluoroethylene, perfluoro(methyl vinyl) ether and perfluoro(8-cyano-5-methyl-3,6-dioxa-1-octene);

tetrafluoroethylene, perfluoro(methyl vinyl) ether and 4-bromo-3,3,4,4-tetrafluorobutene-1;

tetrafluoroethylene, perfluoro(methyl vinyl) ether and 4-iodo-3,3,4,4-tetrafluorobutene-1; and

tetrafluoroethylene, perfluoro(methyl vinyl) ether and perfluoro(2-

phenoxypropyl vinyl) ether.

29. The microfluidic device of Claim 24, wherein the fluoroolefin-based elastomer comprises at least one cure site monomer.

30. The method of Claim 29, wherein the cure site monomer is selected from the group consisting of a bromine-containing olefin, an iodine-containing olefin, a bromine-containing vinyl ether, an iodine-containing vinyl ether, a fluorine-containing olefin comprising a nitrile group, a fluorine-containing vinyl ether comprising a nitrile group, 1,1,3,3,3-pentafluoropropene (2-HPFP), perfluoro(2-phenoxypropyl vinyl) ether, and a non-conjugated diene.

31. The microfluidic device of Claim 24, wherein the fluoroolefin-based elastomer is transparent to one of UV light, visible light, and combinations thereof.

32. The microfluidic device of Claim 24 wherein the fluoroolefin-based elastomer has a Mooney viscosity less than about 40 (ML 1+10 at 121°C).

33. The microfluidic device of Claim 24, wherein the fluoroolefin-based elastomer is permeable to oxygen, carbon dioxide, and nitrogen.

34. A method for functionalizing the surface of a microscale device, the method comprising forming a layer of a functionalized material, wherein the functionalized material is selected from the group consisting of a liquid PFPE precursor material and a liquid fluoroolefin-based precursor material.

35. The method of Claim 34, wherein the layer of functionalized material comprises a latent functional group that is not reacted during a curing process.

36. The method of Claim 35, wherein the latent functional group comprises a methacrylate group.

37. The method of Claim 34, wherein the layer of functionalized material comprises a latent functional group that is introduced in the generation of the liquid precursor material.

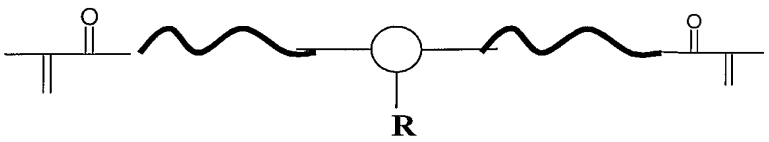
38. The method of Claim 37, wherein the latent functional group comprises a methacrylate group.

39. The method of Claim 34, wherein the layer of functionalized material comprises a two-component liquid PFPE precursor material, wherein

the two-component liquid PFPE precursor material comprises a mixture of two functionalized PFPE components blended in a stoichiometric ratio.

40. The method of Claim 34, wherein the layer of functionalized material comprises a chemical linker group.

41. The method of Claim 40, wherein the chemical linker group comprises the following structure:



wherein:

R comprises an epoxy group;

the circle comprises a linking molecule; and

the wavy line comprises a PFPE chain.

42. The method of Claim 34, wherein the layer of functionalized material comprises a functional monomer.

43. The method of Claim 42, wherein the functional monomer is selected from the group consisting of tert-butyl methacrylate, tert butyl acrylate, dimethylaminopropyl methacrylate, glycidyl methacrylate, hydroxy ethyl methacrylate, aminopropyl methacrylate, allyl acrylate, a cyano acrylate, a cyano methacrylate, a trimethoxysilane acrylate, a trimethoxysilane methacrylate, isocyanato methacrylate, a lactone-containing acrylate, a lactone-containing methacrylate, a sugar-containing acrylate, a sugar-containing methacrylate, polyethylene glycol methacrylate, a nornornane-containing methacrylate, a nornornane-containing acrylate, polyhedral oligomeric silsesquioxane methacrylate, 2-trimethylsiloxyethyl methacrylate, 1H,1H,2H,2H-fluoroctylmethacrylate, pentafluorostyrene, vinyl pyridine, bromostyrene, chlorostyrene, styrene sulfonic acid, fluorostyrene, styrene acetate, acrylamide, and acrylonitrile.

44. The method of Claim 34, wherein the layer of functionalized material is functionalized by exposure to a plasma.

45. The method of Claim 44, wherein the plasma is selected from the group consisting of an Argon plasma and an oxygen plasma.

46. The method of Claim 34, wherein the layer of functionalized

material is functionalized by exposure to UV radiation.

47. The method of Claim 34, comprising attaching a functional moiety to the layer of functionalized material.

48. The method of Claim 47, wherein the functional moiety is selected from the group consisting of a protein, an oligonucleotide, a drug, a catalyst, a dye, a sensor, an analyte, and a charged species capable of changing the wettability of the channel.

49. The method of Claim 34, wherein the layer of functionalized material comprises a microfluidic channel.

50. The method of Claim 34, comprising adhering the layer of functionalized material to a substrate.

51. The method of Claim 50, wherein the substrate comprises a microtiter well.

52. A layer of functionalized material prepared by the method of Claim 34.

53. A method for forming a multilayer device, the method comprising:

(a) providing a first layer of material, wherein the first layer of material comprises a material selected from the group consisting of a liquid perfluoropolyether (PFPE) precursor, a poly(dimethylsiloxane) (PDMS) precursor, a polyurethane precursor, a polyurethane precursor comprising PDMS blocks, a precursor comprising PFPE and PDMS blocks, and a fluoroolefin-based precursor; and

(b) contacting the first layer of material with:

(i) a substrate;

(ii) a second layer of material, wherein the second layer of material comprises a material selected from the group consisting of a perfluoropolyether (PFPE) precursor, a poly(dimethylsiloxane) (PDMS) precursor, a polyurethane precursor, a polyurethane precursor comprising PDMS blocks,

a precursor comprising PFPE and PDMS blocks, and fluoroolefin-based precursor; and wherein the second layer of material can be the same as or different than the first layer of material; and

(iii) combinations thereof;

to form a multilayer device.

54. The method of Claim 53, wherein the first layer of material comprises a fully-cured material.

55. The method of Claim 53, wherein the contacting of the first layer of material with the substrate forms a reversible seal.

56. The method of Claim 53, wherein the first layer of material comprises a partially-cured material.

57. The method of Claim 56, wherein the partially-cured material comprises a partially-cured PFPE precursor material encapped with a methacrylate group.

58. The method of Claim 53, comprising treating the substrate with a silane coupling agent to form a treated substrate.

59. The method of Claim 58, wherein the silane coupling agent is selected from the group consisting of a monohalosilane, a dihalosilane, a trihalosilane, a monoalkoxysilane, a dialkoxysilane, and a trialkoxysilane; and wherein the monohalosilane, dihalosilane, trihalosilane, monoalkoxysilane, dialkoxysilane, and trialkoxysilane are functionalized with a moieties selected from the group consisting of an amine, a methacrylate, an acrylate, a styrenic, an epoxy, an isocyanate, a halogen, an alcohol, a benzophenone derivative, a maleimide, a carboxylic acid, an ester, an acid chloride, and an olefin.

60. The method of Claim 56, comprising:

(a) contacting of the first layer of partially-cured material with the treated substrate; and

(b) treating the first layer of partially cured material to form a bond between the first layer of partially-cured material and the treated substrate.

61. The method of Claim 53, wherein:

(a) the first layer of material comprises a first partially-cured

material; and

(b) the second layer of material comprises a second partially-cured material, wherein the first partially-cured material and the second partially-cured material can be the same or different.

62. The method of Claim 61, comprising:

(a) contacting the first layer of partially-cured material with the second layer of partially-cured material to form a partially-cured multilayer device; and

(b) treating the partially-cured multilayer device to form a fully-cured multilayer device.

63. The method of Claim 62, wherein the treating comprises a process selected from the group consisting of a thermal curing process, a chemical curing process, a photoacid curing process, and a catalytic curing process.

64. The method of Claim 62, wherein the first layer of partially-cured material and second layer of partially-cured material each comprise a thermally-curable PFPE precursor material.

65. The method of Claim 62, wherein the first layer of partially-cured material comprises a polyurethane precursor material and the second layer of partially-cured material comprises a PFPE precursor material.

66. The method of Claim 62, wherein the first layer of partially-cured material comprises a polyurethane precursor comprising poly(dimethylsiloxane) blocks and the second layer of partially-cured material comprises a PFPE precursor material.

67. The method of Claim 62, wherein the first layer of partially-cured material comprises a precursor material comprising a PFPE block and a PDMS block and the second layer of partially-cured material comprises a PFPE precursor material.

68. The method of Claim 62, wherein the first layer of partially-cured material comprises a PDMS precursor and the second layer of partially-cured material comprises a PFPE precursor material.

69. The method of Claim 68, wherein the PFPE precursor material

is encapped with a methacrylate group.

70. The method of Claim 68, comprising treating the PDMS precursor with a plasma treatment followed by treatment with a silane coupling agent.

71. The method of Claim 70, wherein the silane coupling agent is selected from the group consisting of a monohalosilane, a dihalosilane, a trihalosilane, a monoalkoxysilane, a dialkoxysilane, and a trialkoxysilane; and wherein the monohalosilane, dihalosilane, trihalosilane, monoalkoxysilane, dialkoxysilane, and trialkoxysilane are functionalized with a moieties selected from the group consisting of an amine, a methacrylate, an acrylate, a styrenic, an epoxy, an isocyanate, a halogen, an alcohol, a benzophenone derivative, a maleimide, a carboxylic acid, an ester, an acid chloride, and an olefin.

72. The method of Claim 62, comprising:

(a) contacting the partially-cured multilayer structure with a substrate, wherein the substrate is coated with a partially-cured precursor material to form a second partially-cured multilayer device; and

(b) treating the second partially-cured multilayer device to form a second fully-cured multilayer device.

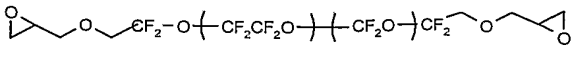
73. The method of Claim 72, wherein the treating comprises a process selected from the group consisting of a thermal curing process, a chemical curing process, a photoacid curing process, and a catalytic curing process.

74. The method of Claim 53, wherein at least one of the first layer of material and the second layer of material comprises a material formed from a two-component PFPE precursor material, wherein the two-component PFPE precursor material comprises a mixture of two functionalized PFPE components blended in a stoichiometric ratio.

75. The method of Claim 74, wherein the two-component PFPE precursor system comprises a mixture of components selected from the group consisting of an epoxy/amine mixture, a hydroxyl/isocyanate mixture, a hydroxyl/acid chloride mixture, and a hydroxyl/chlorosilane mixture.

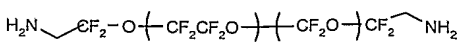
76. The method of Claim 75, wherein epoxy/amine mixture

comprises a PFPE diepoxy compound comprising the following structure:



; and

a PFPE diamine compound comprising the following structure:



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77. The method of Claim 75, wherein the epoxy/amine mixture comprises a stoichiometric ratio ranging from about 4:1 epoxy:amine to about 1:4 epoxy:amine.

78. The method of Claim 77, wherein the stoichiometric ratio is about 4:1 epoxy:amine.

79. The method of Claim 78, comprising:

(a) providing a substrate, wherein the substrate is treated with a silane coupling agent;

(b) contacting the first layer of material formed from a two-component PFPE precursor material comprising a stoichiometric ratio of about 4:1 epoxy:amine with the substrate; and

(b) treating first layer of material and the substrate to form a multilayer device.

80. The method of Claim 79, wherein the silane coupling agent comprises aminopropyltriethoxy silane.

81. The method of Claim 77, wherein the stoichiometric ratio is about 1:4 epoxy:amine.

82. The method of Claim 81, comprising:

(i) providing a first layer of material comprising a stoichiometric ratio of about 1:4 epoxy:amine;

(ii) contacting the first layer of material comprising a stoichiometric ratio of about 1:4 epoxy:amine with a second layer of material comprising a stoichiometric ratio of about 4:1 epoxy:amine; and

(iii) treating the two layers of material to form a multilayer device.

83. The method of Claim 78, comprising:

(i) providing a first layer of PDMS material;

(ii) treating the first layer of PDMS material with plasma treatment followed by treatment with a silane coupling agent to form a treated layer of PDMS material;

(iii) contacting the treated layer of PDMS material with a second layer of material comprising a stoichiometric ratio of about 4:1 epoxy:amine; and

(iv) treating the two layers of material to form a multilayer device.

84. The method of Claim 83, wherein the silane coupling agent comprises aminopropyltriethoxy silane.

85. The method of Claim 74, comprising:

(a) providing a first layer of material formed from a two-component PFPE precursor material, wherein the two-component PFPE precursor material comprises a mixture of two functionalized PFPE components blended in a stoichiometric ratio;

(b) treating the first layer of material to form a first layer of partially-cured material;

(c) contacting the first layer of partially-cured material with one of:

(i) a substrate;

(ii) a second layer of material; and

(iii) combinations thereof; and

(d) treating the first layer of partially-cured material to adhere the partially-cured material to one of the substrate, a second layer of material, and combinations thereof.

86. The method of Claim 85, wherein the substrate is selected from the group consisting of a glass material, a quartz material, a silicon material, and a fused silica material.

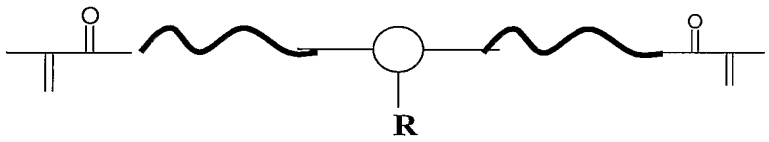
87. The method of Claim 86, comprising treating the substrate with a silane coupling agent.

88. The method of Claim 87, wherein the silane coupling agent is selected from the group consisting of a monohalosilane, a dihalosilane, a trihalosilane, a monoalkoxysilane, a dialkoxysilane, and a trialkoxysilane; and wherein the monohalosilane, dihalosilane, trihalosilane, monoalkoxysilane, dialkoxysilane, and trialkoxysilane are functionalized with a moieties selected from the group consisting of an amine, a methacrylate, an acrylate, a styrenic, an epoxy, an isocyanate, a halogen, an alcohol, a benzophenone derivative, a maleimide, a carboxylic acid, an ester, an acid chloride, and an olefin.

89. The method of Claim 85, wherein the second layer of material comprises a PFPE precursor material.

90. The method of Claim 85, wherein the second layer of material comprises a poly(dimethylsiloxane) material, wherein the poly(dimethylsiloxane) material is treated with an oxygen plasma followed by treatment with a silane coupling agent.

91. The method of Claim 53, wherein the PFPE precursor material comprises the following structure:



wherein:

R comprises an epoxy group;

the circle comprises a linking molecule; and

the wavy line comprises a PFPE chain.

92. The method of Claim 91, comprising photocuring the PFPE precursor material to form a layer of fully-cured PFPE material.

93. The method of Claim 92, comprising:

(a) contacting the layer of fully-cured PFPE material with one of:

(i) a substrate;

(ii) a second layer of material; and

(iii) combinations thereof; and

(b) treating the fully-cured material to bond it to one of the substrate, the second layer of material, and combinations

thereof.

94. The method of Claim 93, wherein the substrate is selected from the group consisting of a glass material, a quartz material, a silicon material, and a fused silica material.

95. The method of Claim 94, comprising treating the substrate with a silane coupling agent.

96. The method of Claim 95, wherein the silane coupling agent comprises aminopropyltriethoxy silane.

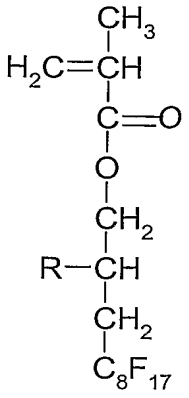
97. The method of Claim 93, wherein the second layer of material comprises a PFPE material.

98. The method of Claim 93, wherein the second layer of material comprises a treated PDMS material, and wherein the treated PDMS material is treated with an oxygen plasma followed by treatment with a silane coupling agent.

99. The method of Claim 98, wherein the silane coupling agent is selected from the group consisting of a monohalosilane, a dihalosilane, a trihalosilane, a monoalkoxysilane, a dialkoxysilane, and a trialkoxysilane; and wherein the monohalosilane, dihalosilane, trihalosilane, monoalkoxysilane, dialkoxysilane, and trialkoxysilane are functionalized with a moieties selected from the group consisting of an amine, a methacrylate, an acrylate, a styrenic, an epoxy, an isocyanate, a halogen, an alcohol, a benzophenone derivative, a maleimide, a carboxylic acid, an ester, an acid chloride, and an olefin.

100. The method of Claim 53, comprising blending the PFPE precursor with a functional monomer to form a PFPE precursor blend.

101. The method of Claim 100, wherein the functional monomer comprises the following structure:



102. The method of Claim 100, comprising photocuring the PFPE precursor blend to form a layer of fully-cured PFPE material.

103. The method of Claim 102, comprising:

(a) contacting the layer of fully-cured PFPE material with one of:

(i) a substrate;

(ii) a second layer of material; and

(iii) combinations thereof; and

(b) treating the layer of fully-cured material to bond it to one of the substrate, the second layer of material, and combinations thereof.

104. The method of Claim 103, wherein the substrate is selected from the group consisting of a glass material, a quartz material, a silicon material, and a fused silica material.

105. The method of Claim 104, comprising treating the substrate with a silane coupling agent.

106. The method of Claim 105, wherein the silane coupling agent is selected from the group consisting of a monohalosilane, a dihalosilane, a trihalosilane, a monoalkoxysilane, a dialkoxysilane, and a trialkoxysilane; and wherein the monohalosilane, dihalosilane, trihalosilane, monoalkoxysilane, dialkoxysilane, and trialkoxysilane are functionalized with a moieties selected from the group consisting of an amine, a methacrylate, an acrylate, a styrenic, an epoxy, an isocyanate, a halogen, an alcohol, a benzophenone derivative, a maleimide, a carboxylic acid, an ester, an acid chloride, and an olefin.

107. The method of Claim 103, wherein the second layer of material

comprises a PFPE material.

108. The method of Claim 103, wherein the second layer of material comprises a treated PDMS material, and wherein the treated PDMS material is treated with an oxygen plasma followed by treatment with a silane coupling agent.

109. The method of Claim 108, wherein the silane coupling agent comprises aminopropyltriethoxy silane.

110. The method of Claim 53, wherein the substrate is selected from the group consisting of a glass material, a quartz material, a silicon material, a fused silica material, an elastomeric material, and a rigid thermoplastic material.

111. The method of Claim 110, wherein the elastomeric material is selected from the group consisting of poly(dimethylsiloxane) (PDMS), Kratons, buna rubber, natural rubber, a fluorelastomer, chloroprene, butyl rubber, nitrile rubber, polyurethane, or a thermoplastic elastomer.

112. The method of Claim 110, wherein the rigid thermoplastic material is selected from the group consisting of polystyrene, poly(methyl methacrylate), a polyester, a polycarbonate, a polyimide, a polyamide, a polyvinylchloride, a polyolefin, a poly(ketone), a poly(ether ether ketone), and a poly(ether sulfone).

113. The method of Claim 110, comprising treating the substrate with a silane coupling agent.

114. The method of Claim 113, wherein the silane coupling agent is selected from the group consisting of trimethylsilyl propyl methacrylate and aminopropyltriethoxy silane.

115. The method of Claim 53, wherein the substrate comprises a microtiter plate.

116. The method of Claim 53, wherein the first layer of material comprises at least one microscale channel.

117. The method of Claim 53, wherein the first layer of material comprises at least one nanoscale channel.

118. A multilayer device formed by the method of Claim 53.

119. The multilayer device of Claim 118, wherein the multilayer

device comprises a microfluidic device.

120. A method of adhering one of a microscale device, a nanoscale device, and combinations thereof to a substrate, the method comprising:

(a) providing one of a microscale device, a nanoscale device, and combinations thereof, wherein the device comprises a material selected from the group consisting of a perfluoropolyether material and a fluoroolefin-based material;

(b) contacting the device with a substrate;

(c) coating the device and the substrate with a liquid precursor encasing material;

(d) solidifying the liquid precursor encasing material to mechanically bind the device to the substrate.

121. The method of Claim 120, wherein the substrate is selected from the group consisting of a glass material, a quartz material, a silicon material, a fused silica material, an elastomeric material, and a rigid thermoplastic material.

122. The method of Claim 121, wherein the elastomeric material is selected from the group consisting of poly(dimethylsiloxane) (PDMS), Kratons, buna rubber, natural rubber, a fluorelastomer, chloroprene, butyl rubber, nitrile rubber, polyurethane, or a thermoplastic elastomer.

123. The method of Claim 121, wherein the rigid thermoplastic material is selected from the group consisting of polystyrene, poly(methyl methacrylate), a polyester, a polycarbonate, a polyimide, a polyamide, a polyvinylchloride, a polyolefin, a poly(ketone), a poly(ether ether ketone), and a poly(ether sulfone).

124. The method of Claim 120, wherein the substrate is treated with a silane coupling agent.

125. The method of Claim 124, wherein the silane coupling agent is selected from the group consisting of trimethylsilyl propyl methacrylate and aminopropyltriethoxy silane.

126. The method of Claim 120, wherein the solidifying of the liquid precursor encasing material comprises a curing process.

127. The method of Claim 120, wherein the liquid precursor encasing material is selected from the group consisting of a liquid epoxy precursor and a polyurethane.

128. A method for forming one of a microstructure, a nanostructure, and combinations thereof, the method comprising:

(a) disposing a first PFPE precursor material on a substrate to form a first layer of liquid PFPE precursor material on the substrate;

(b) treating the first layer of PFPE precursor material to form a first layer of treated PPFE material on the substrate;

(c) placing a multidimensional structure on the first layer of treated PFPE material, wherein the multidimensional structure has a characteristic selected from the group consisting of (i) degradability; (ii) selectively soluble; and (iii) combinations thereof;

(d) encasing the multidimensional structure with a second layer of liquid PFPE precursor material;

(e) treating the second layer of PFPE precursor material to form a second layer of treated PFPE material; and

(f) removing the degradable or selectively soluble material from the second layer of treated PFPE material to form one of a microstructure, a nanostructure, and combinations thereof.

129. The method of Claim 128, wherein the degradable or selectively soluble material is selected from the group consisting of a wax, a photoresist, a poly(lactic acid), a polylactone, a polysulfone, a polyelectrolyte, a cellulose fiber, a water soluble polymer, a solvent soluble polymer, a salt, a solid organic compound, and a solid inorganic compound.

130. The method of Claim 128, wherein the removing of the degradable or selectively soluble material comprises a process selected from the group consisting of a thermal process, a photochemical process, and a dissolution process.

131. The method of Claim 128, comprising mixing at least one of the

first PFPE precursor material and the second PFPE precursor material with one of a thermal free radical initiator and a photoinitiator.

132. The method of Claim 128, wherein the treating of at least one of the first layer of PFPE precursor material and the second layer of PFPE precursor material comprises a curing process.

133. The method of Claim 132, wherein the curing process is selected from the group consisting of a thermal curing process and a photochemical curing process.

134. The method of Claim 128, wherein the encasing of the multidimensional structure with a second layer of liquid PFPE precursor material comprises a spin-coating process.

135. A microstructure prepared by the method of Claim 128.

136. The microstructure of Claim 135, wherein the microstructure comprises a microfluidic channel.

137. A nanostructure prepared by the method of Claim 128.

138. The nanostructure of Claim 137, wherein the nanostructure comprises a nanoscale channel.

139. A method of forming one of a microstructure, a nanostructure, and combinations thereof, the method comprising:

(a) providing a patterned layer of perfluorinated perfluoropolyether (PFPE) material, wherein the patterned layer of PFPE material comprises a patterned surface;

(b) disposing a predetermined volume of degradable or selectively soluble material on the patterned surface of the patterned layer of PFPE material;

(c) encasing the predetermined volume of degradable or selectively soluble material on the patterned surface of the patterned layer of PFPE material; and

(d) removing the predetermined volume of degradable or selectively soluble material from the patterned surface of the layer of PFPE material to form one of a microscale structure, a nanoscale structure, and combinations

thereof.

140. The method of Claim 139, wherein the degradable or selectively soluble material is selected from the group consisting of a wax, a photoresist, a poly(lactic acid), a polylactone, a polysulfone, a polyelectrolyte, a cellulose fiber, a water soluble polymer, a solvent soluble polymer, a salt, a solid organic compound, and a solid inorganic compound.

141. The method of Claim 140, wherein the removing of the predetermined volume of degradable or selectively soluble material comprises a process selected from the group consisting of a thermal process, a photochemical process, and a dissolution process.

142. A microstructure prepared by the method of Claim 139.

143. The microstructure of Claim 142, wherein the microstructure comprises a microfluidic channel.

144. A nanostructure prepared by the method of Claim 139.

145. The nanostructure of Claim 144, wherein the nanostructure comprises a nanoscale channel.

146. A method of flowing a material in a microfluidic device, the method comprising:

(a) providing a microfluidic device comprising at least one layer of

(i) a perfluoropolyether (PFPE) material having a characteristic selected from the group consisting of a viscosity greater than about 100 centistokes (cSt) and a viscosity less than about 100 cSt, provided that the liquid PFPE precursor material having a viscosity less than 100 cSt is not a free-radically photocurable PFPE material;

(ii) a functionalized PFPE material;

(iii) a fluoroolefin-based elastomer; and

(iv) combinations thereof; and

(b) flowing a material in the microscale channel.

147. The method of Claim 146, wherein the at least one layer of material covers a surface of at least one of the one or more microscale

channels.

148. The method of Claim 147, wherein the at least one layer of material comprises a functionalized surface.

149. The method of Claim 146, wherein the one or more microscale channels comprises an integrated network of microscale channels.

150. The method of Claim 149, wherein the microscale channels of the integrated network intersect predetermined points.

151. The method of Claim 146, wherein the microfluidic device comprises one or more patterned layers of a first polymeric material, and wherein the one or more patterned layers of the first polymeric material defines the one or more microscale channels.

152. The method of Claim 151, wherein the microfluidic device further comprises a patterned layer of a second polymeric material, wherein the patterned layer of the second polymeric material is in operative communication with the at least one of the one or more patterned layers of the first polymeric material.

153. The method of Claim 151, wherein the patterned at least one layer of material comprises a functionalized surface.

154. The method of Claim 151, wherein the one or more microscale channels comprises an integrated network of microscale channels.

155. The method of Claim 154, wherein the microscale channels of the integrated network intersect predetermined points.

156. The method of Claim 151, wherein the patterned layer of the first polymeric material comprises a plurality of holes.

157. The method of Claim 156, wherein at least one of the plurality of holes comprises an inlet aperture.

158. The method of Claim 156, wherein at least one of the plurality of holes comprises an outlet aperture.

159. The method of Claim 156, wherein the microfluidic device comprises one or more valves.

160. The method of Claim 146, wherein the material is selected from the group consisting of a fluid, an organic solvent, an aqueous solution, an aqueous solution dispersed in a substantially non-aqueous solvent, a

surfactant mixture, and a reaction mixture.

161. The method of Claim 146, wherein the material flows in a predetermined direction along the microscale channel.

162. The method of Claim 146, comprising applying a driving force to move the material along the microscale channel.

163. A method of mixing two or more materials, the method comprising:

(a) providing a microscale device comprising at least one layer of:

(i) a perfluoropolyether (PFPE) material having a characteristic selected from the group consisting of: a viscosity greater than about 100 centistokes (cSt) and a viscosity less than about 100 cSt, provided that the liquid PFPE precursor material having a viscosity less than 100 cSt is not a free-radically photocurable PFPE material;

(ii) a functionalized PFPE material;

(iii) a fluoroolefin-based elastomer; and

(iv) combinations thereof; and

(b) contacting a first material and a second material in the device to mix the first and second materials.

164. The method of Claim 163, wherein the microscale device is selected from the group consisting of a microfluidics device and a microtiter plate.

165. The method of Claim 164, wherein the microfluidics device comprises one or more microscale channels.

166. The method of Claim 165, wherein the at least one layer of material covers a surface of at least one of the one or more microscale channels.

167. The method of Claim 166, wherein the at least one layer of material comprises a functionalized surface.

168. The method of Claim 165, wherein the microfluidic device comprises at least one patterned layer of a first polymeric material, and

wherein the patterned layer of the first polymeric material defines the one or microscale channels.

169. The method of Claim 168, wherein the microfluidic device further comprises a patterned layer of a second polymeric material, wherein the patterned layer of the second polymeric material is in operative communication with the at least one of the one or more patterned layers of first polymeric material.

170. The method of Claim 168, wherein the patterned layer of first polymeric material comprises a functionalized surface.

171. The method of Claim 165, wherein the one or more microscale channels comprises an integrated network of microscale channels.

172. The method of Claim 171, wherein the microscale channels of the integrated network intersect at predetermined points.

173. The method of Claim 165, wherein the contacting of the first material and the second material is performed in a mixing region defined in the one or more microscale channels.

174. The method of Claim 173, wherein the mixing region comprises a geometry selected from the group consisting of a T-junction, a serpentine, an elongated channel, a microscale chamber, and a constriction.

175. The method of Claim 165, wherein the first material and the second material are disposed in separate channels of the microfluidic device.

176. The method of Claim 175, wherein the contacting of the first material and the second material is performed in a mixing region defined by an intersection of the channels.

177. The method of Claim 176, wherein the mixing region comprises a geometry selected from the group consisting of a T-junction, a serpentine, an elongated channel, a microscale chamber, and a constriction.

178. The method of Claim 164, comprising flowing the first material and the second material in a predetermined direction in the microfluidic device.

179. The method of Claim 164, comprising flowing the mixed materials in a predetermined direction in the microfluidic device.

180. The method of Claim 164, comprising contacting the mixed

material with a third material to form a second mixed material.

181. The method of Claim 164, comprising flowing the mixed materials to an outlet aperture of the microfluidic device.

182. The method of Claim 164, comprising applying a driving force to move the materials through the microfluidic device.

183. The method of Claim 164, wherein the microtiter plate comprises one or more wells.

184. The method of Claim 183, wherein the at least one layer of material covers a surface of at least one of the one or more wells.

185. The method of Claim 184, wherein the at least one layer of material comprises a functionalized surface.

186. The method of Claim 163, comprising recovering the mixed materials.

187. A method of screening a sample for a characteristic, the method comprising:

(a) providing a microscale device comprising at least one layer of

(i) a perfluoropolyether (PFPE) material having a characteristic selected from the group consisting of: a viscosity greater than about 100 centistokes (cSt) and a viscosity less than about 100 cSt, provided that the liquid PFPE precursor material having a viscosity less than 100 cSt is not a free-radically photocurable PFPE material;

(ii) a functionalized PFPE material;

(iii) a fluoroolefin-based elastomer; and

(iv) combinations thereof;

(b) providing a target material;

(c) disposing the sample in the microscale device;

(d) contacting the sample with the target material; and

(e) detecting an interaction between the sample and the target material,

wherein the presence or the absence of the interaction is indicative of

the characteristic of the sample.

188. The method of Claim 187, wherein the microscale device is selected from the group consisting of a microfluidic device and a microtiter plate.

189. The method of Claim 188, wherein the microfluidic device comprises one or more microscale channels.

190. The method of Claim 189, wherein the at least one layer of material covers a surface of at least one of the one or more microscale channels.

191. The method of Claim 189, wherein the microfluidic device comprises at least one patterned layer of first polymeric material, and wherein the patterned layer of the first polymeric material defines the one or microscale channels.

192. The method of Claim 191, wherein the microfluidic device further comprises a patterned layer of a second polymeric material, wherein the patterned layer of the second polymeric material is in operative communication with the at least one of the one or more patterned layers of the first polymeric material.

193. The method of Claim 191, wherein the one or more microscale channels comprises an integrated network of microscale channels.

194. The method of Claim 193, wherein the microscale channels of the integrated network intersect at predetermined points.

195. The method of Claim 188, wherein the microtiter plate comprises one or more wells.

196. The method of Claim 195, wherein the at least one layer of material covers a surface of at least one of the one or more wells.

197. The method of Claim 187, comprising disposing the target material in the microscale device.

198. The method of Claim 197, wherein the target material is bound to the functionalized surface.

199. The method of Claim 187, wherein the target material comprises one or more of an antigen, an antibody, an enzyme, a restriction enzyme, a dye, a fluorescent dye, a sequencing reagent, a PCR reagent, a primer, a

receptor, a ligand, a chemical reagent, or a combination thereof.

200. The method of Claim 187, wherein the sample is bound to the functionalized surface.

201. The method of Claim 187, wherein the sample is selected from the group consisting of a therapeutic agent, a diagnostic agent, a research reagent, a catalyst, a metal ligand, a non-biological organic material, an inorganic material, a foodstuff, soil, water, and air.

202. The method of Claim 187, wherein the sample comprises one or more members of one or more libraries of chemical or biological compounds or components.

203. The method of Claim 187, wherein the sample comprises one or more of a nucleic acid template, a sequencing reagent, a primer, a primer extension product, a restriction enzyme, a PCR reagent, a PCR reaction product, or a combination thereof.

204. The method of Claim 187, wherein the sample comprises one or more of an antibody, a cell receptor, an antigen, a receptor ligand, an enzyme, a substrate for an enzyme, an immunochemical, an immunoglobulin, a virus, a virus binding component, a protein, a cellular factor, a growth factor, an inhibitor, or a combination thereof.

205. The method of Claim 187, comprising disposing a plurality of samples in the microscale device.

206. The method of Claim 187, wherein the interaction comprises a binding event.

207. The method of Claim 187, wherein the detecting of the interaction is performed by at least one or more of a spectrophotometer, a fluorometer, a photodiode, a photomultiplier tube, a microscope, a scintillation counter, a camera, a CCD camera, film, an optical detection system, a temperature sensor, a conductivity meter, a potentiometer, an amperometric meter, a pH meter, or a combination thereof.

208. A method of separating a material, the method comprising:

(a) providing a microfluidic device comprising at least one layer of

(i) a perfluoropolyether (PFPE) material having a

characteristic selected from the group consisting of: a viscosity greater than about 100 centistokes (cSt) and a viscosity less than about 100 cSt, provided that the liquid PFPE precursor material having a viscosity less than 100 cSt is not a free-radically photocurable PFPE material;

(ii) a functionalized PFPE material;

(iii) a fluoroolefin-based elastomer; and

(iv) combinations thereof; and wherein the microfluidics device comprises one or more microscale channels, and wherein at least one of the one or more microscale channels comprises a separation region;

(b) disposing a mixture comprising at least a first material and a second material in the microfluidic device;

(c) flowing the mixture through the separation region; and

(d) separating the first material from the second material in the separation region to form at least one separated material.

209. The method of Claim 208, wherein the at least one layer of material covers a surface of at least one of the one or more microscale channels.

210. The method of Claim 208, wherein the one or more microscale channels comprises an integrated network of microscale channels.

211. The method of Claim 209, wherein the microscale channels of the integrated network intersect predetermined points.

212. The method of Claim 208, wherein the microfluidic device comprises one or more patterned layers of a first polymeric material, and wherein the one or more patterned layers of the first polymeric material defines the one or more microscale channels.

213. The method of Claim 212, wherein the microfluidic device further comprises a patterned layer of a second polymeric material, wherein the patterned layer of the second polymeric material is in operative

communication with the at least one of the one or more patterned layers of the first polymeric material.

214. The method of Claim 212, wherein the one or more microscale channels comprises an integrated network of microscale channels.

215. The method of Claim 214, wherein the microscale channels of the integrated network intersect predetermined points.

216. The method of Claim 208, wherein the separation region comprises a functionalized surface.

217. The method of Claim 208, wherein the separation region comprises a chromatographic material.

218. The method of Claim 217, wherein the chromatographic material is selected from the group consisting of a size-separation matrix, an affinity-separation matrix; and a gel-exclusion matrix, or a combination thereof.

219. The method of Claim 208, wherein the first or second material comprises one or more members of one or more libraries of chemical or biological compounds or components.

220. The method of Claim 208, wherein the first or second material comprises one or more of a nucleic acid template, a sequencing reagent, a primer, a primer extension product, a restriction enzyme, a PCR reagent, a PCR reaction product, or a combination thereof.

221. The method of Claim 208, wherein the first or second material comprises one or more of an antibody, a cell receptor, an antigen, a receptor ligand, an enzyme, a substrate for an enzyme, an immunochemical, an immunoglobulin, a virus, a virus binding component, a protein, a cellular factor, a growth factor, an inhibitor, or a combination thereof.

222. The method of Claim 208, comprising detecting the separated material.

223. The method of Claim 222, wherein the detecting of the separated material is performed by at least one or more of a spectrophotometer, a fluorometer, a photodiode, a photomultiplier tube, a microscope, a scintillation counter, a camera, a CCD camera, film, an optical detection system, a temperature sensor, a conductivity meter, a potentiometer, an amperometric meter, a pH meter, or a combination thereof.

224. A method of dispensing a material, the method comprising:

(a) providing a microfluidic device comprising at least one layer of:

(i) a perfluoropolyether (PFPE) material having a characteristic selected from the group consisting of: a viscosity greater than about 100 centistokes (cSt) and a viscosity less than about 100 cSt, provided that the liquid PFPE precursor material having a viscosity less than 100 cSt is not a free-radically photocurable PFPE material;

(ii) a functionalized PFPE material;

(iii) a fluoroolefin-based elastomer; and

(iv) combinations thereof; and wherein the microfluidics device comprises one or more microscale channels, and wherein at least one of the one or more microscale channels comprises an outlet aperture;

(b) providing at least one material;

(c) disposing at least one material in at least one of the one or more microscale channels; and

(d) dispensing at least one material through the outlet aperture.

225. The method of Claim 224, wherein the at least one layer of material covers a surface of at least one of the one or more microscale channels.

226. The method of Claim 225, wherein the one or more microscale channels comprises an integrated network of microscale channels.

227. The method of Claim 226, wherein the microscale channels of the integrated network intersect predetermined points.

228. The method of Claim 224, wherein the microfluidic device comprises one or more patterned layers of a first polymeric material, and wherein the one or more patterned layers of the first polymeric material defines the one or more microscale channels.

229. The method of Claim 228, wherein the microfluidic device further comprises a patterned layer of a second polymeric material, wherein the patterned layer of the second polymeric material is in operative communication with the at least one of the one or more patterned layers of the first polymeric material.

230. The method of Claim 228, wherein the patterned at least one layer of material comprises a functionalized surface.

231. The method of Claim 228, wherein the one or more microscale channels comprises an integrated network of microscale channels.

232. The method of Claim 231, wherein the microscale channels of the integrated network intersect predetermined points.

233. The method of Claim 224, wherein the material comprises a drug.

234. The method of Claim 233, comprising metering a predetermined dosage of the drug.

235. The method of Claim 234, comprising dispensing the predetermined dosage of the drug.

236. The method of Claim 224, wherein the material comprises an ink composition.

237. The method of Claim 236, comprising dispensing the ink composition on a substrate.

238. The method of Claim 237, wherein the dispensing of the ink composition on a substrate forms a printed image.